
C. U.S. DOE, OFFICE OF TRANSPORTATION TECHNOLOGY,
FUEL CELLS FOR TRANSPORTATION PROGRAM

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Proton Exchange Membrane (PEM) Fuel Cells for Transportation

Energy Efficiency and Renewable Energy
Office of Transportation Technologies

Patrick Davis

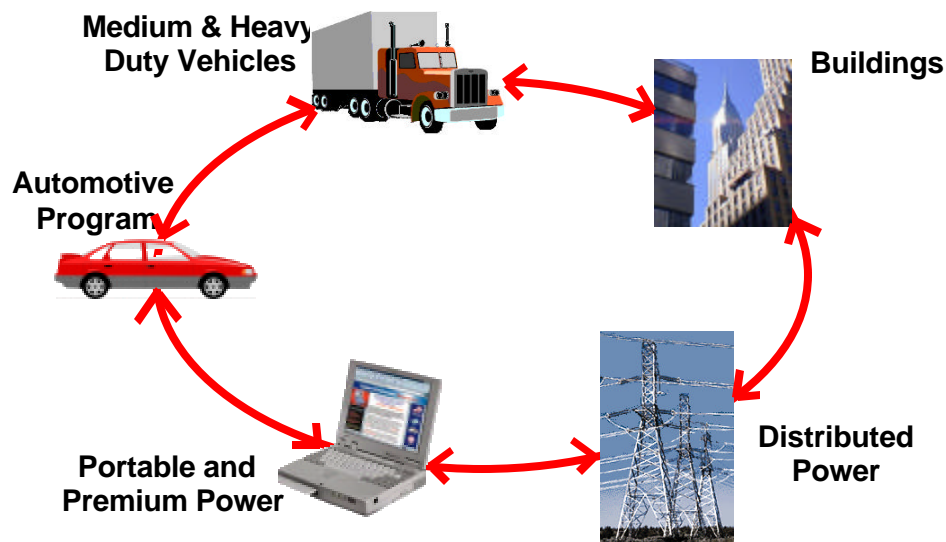
*Solid State Energy
Conversion Alliance
Workshop
June 1, 2000*



EERE PEM Fuel Cell Development Efforts Benefit Multiple Applications



Fuel Cells





Projected Fuel Cell Vehicle Performance (PNGV-Class Series Hybrid)



Fuel Cells

Projected Mileage, MPG

	Gasoline Fueled	Hydrogen Fueled
Urban Fuel Economy	79	101
Highway Fuel Economy	97	128
Combined	86	111

Note: Based on NREL/ADVISOR system modeling using target fuel cell efficiencies.

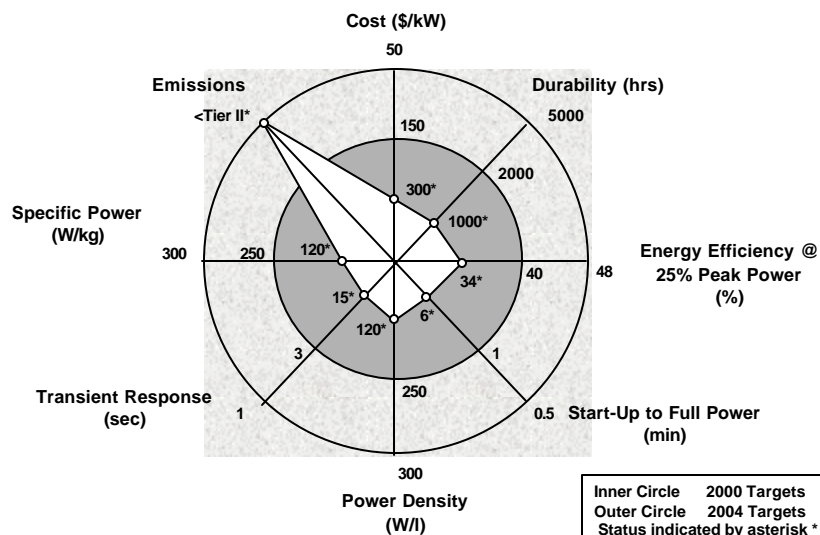
108 mpg



Status vs Technical Targets 50-kW Gasoline-Fueled Fuel Cell System



Fuel Cells





DOE Transportation Fuel Cell Program Fuel Strategy



Fuel Cells

Simultaneously pursue parallel paths for near- and long-term

Near-term: Fuel flexible fuel processor

Primary focus \Rightarrow Advanced petroleum-based fuel
 \Rightarrow Methanol, Ethanol, Natural Gas



Long-term: Renewable hydrogen

Primary focus \Rightarrow On-board vehicle storage



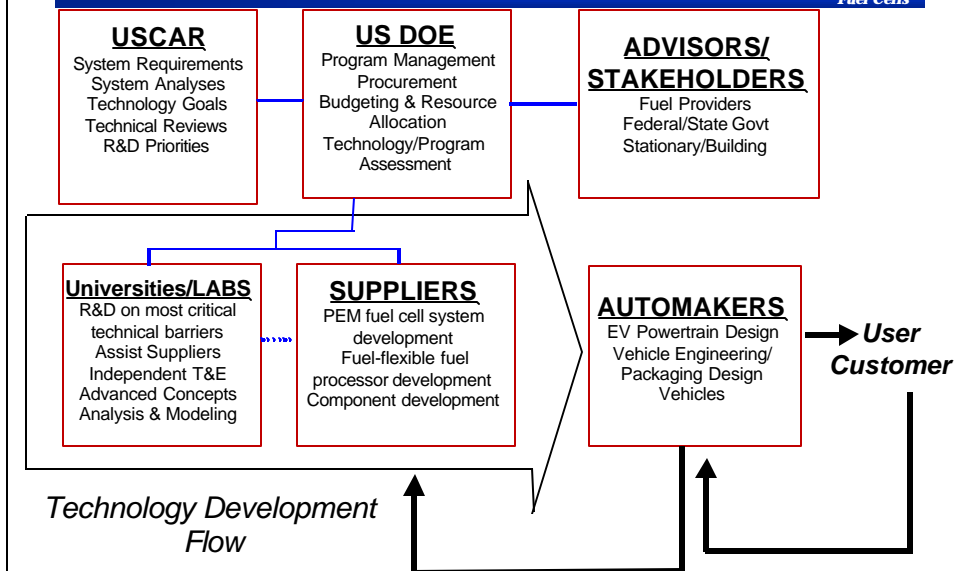
Advanced fuel is "gasoline-like," facilitates on-board processing, and is compatible with existing infrastructure. Gas-to-liquids, methanol, and ethanol may be used as blending constituents.



Structure of DOE Transportation Fuel Cell Program



Fuel Cells





Program is Focused on Technical Barriers



Fuel Cells

There are significant technical and economic reasons that will keep fuel cell vehicles from making significant market penetration for 10 years.

- **Technical Barriers**
 - Platinum Usage
 - Durability
 - Air Systems
 - Start-up
 - Fuel Infrastructure
 - Cost
- **Economic Barriers**
 - Competition from other technologies
 - Fuel Cell Cost
 - Economics of fuel introduction
 - Cost of fuel



Projects and Funding by Budget Category



Systems

- Plug Power/Epyx
- IFC
- Energy Partners, AlliedSignal
- ANL

FY00: \$6.0M

Fuel Processing

- NUVERA
- Hydrogen Burner
- McDermott
- Plug Power/UOP
- AlliedSignal
- Arcadis
- ANL, LANL, PNNL

FY00: \$17.0M

Stack Subsystem Components

- Energy Partners, AlliedSignal, IFC, Plug Power
- IGT, Electrochem
- 3M, SwRI/Gore, Foster-Miller
- Vairex, A.D. Little, AlliedSignal, Meruit
- Spectracorp
- LANL, LBNL

FY00: \$14.0M



Accomplishments



Systems

- Demonstration of first gasoline to PEM experiment (1997), first 10kW gasoline system (1999).
- IFC Hydrogen Sys.
- MeOH (GM) system led to Zafira demonstration



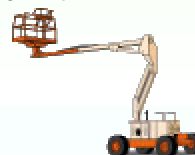
Fuel Processing

- Epyx gasoline fuel processors - 50kW
- PNNL microchannel steam reformer
- ANL autothermal catalyst development
- GM MeOH steam reforming.
- Los Alamos PROX.



Stack Subsystem Components

- Los Alamos low platinum electrode, reconfigured anode.
- Inst. Of Gas Tech. \$10/KW bipolar plate.
- Sensors and controls
- AlliedSignal stack demonstrated in JLG boomlift.



Office of Transportation Technologies Interest in Solid Oxide Fuel Cell Technology



Fuel Cells

- Applications of interest in transportation
 - Auxiliary Power for Heavy or Light Duty
 - Propulsion for Heavy Duty
- Recently completed study by Parsons Infrastructure and Technology indicates auxiliary power application particularly of interest.
- OTT will continue to investigate application of solid-oxide fuel cell technology to transportation and support R&D where appropriate.

Barriers to transportation applications:

Heavy Duty - Cost, Maturity, Durability/Robustness

Light Duty - Cost, Maturity, Start-up, Thermal Cycling



Summary



Fuel Cells

- **PEM fuel cell technology leverages multiple applications to achieve significant benefits in energy efficiency.**
- **Major technical barriers exist that prevent the introduction of PEM technology into today's light duty transportation options.**
- **The Office of Transportation Technology Fuel Cell for Transportation program is addressing critical technical barriers.**
- **Solid Oxide technology may find a role in transportation applications, but, like PEM, has significant technical and economic barriers to overcome.**